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SCIENTIFIC ARTICLE

A randomised comparative study of the effect of Airtraq optical laryngoscope vs. Macintosh laryngoscope on intraocular pressure in non-ophthalmic surgery

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KEYWORDS
Airtraq;
Haemodynamic response;
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Macintosh blade

Abstract
Background: We compared intraocular pressure changes following laryngoscopy and intubation with conventional Macintosh blade and Airtraq optical laryngoscope.
Methods: Ninety adult patients were randomly assigned to study group or control group. Study group ($n = 45$) – Airtraq laryngoscope was used for laryngoscopy. Control group ($n = 45$) – conventional Macintosh laryngoscope was used for laryngoscopy. Preoperative baseline intraocular pressure was measured with Schiotz tonometer. Laryngoscopy was done as per group protocol. Intraocular pressure and haemodynamic parameters were recorded just before insertion of the device and subsequently three times at an interval of one minute after insertion of the device.
Results: Patient characteristics, baseline haemodynamic parameters and baseline intraocular pressure were comparable in the two groups. Following insertion of the endotracheal tube with Macintosh laryngoscope, there was statistically significant rise in heart rate and intraocular pressure compared to Airtraq group. There was no significant change in MAP. Eight patients in Macintosh group had tongue-lip-dental trauma during intubation, while only 2 patients received upper airway trauma in Airtraq group.
Conclusion: We conclude that Airtraq laryngoscope in comparison to Macintosh laryngoscope results in significantly fewer rises in intraocular pressure and clinically less marked increase in haemodynamic response to laryngoscopy and intubation.

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PALAVRAS-CHAVE
Airtraq;
Resposta hemodinâmica;
Pressão intraocular;
Lâmina Macintosh

Estudo comparativo randomizado do efeito do laringoscópio óptico Airtraq vs. laringoscópio Macintosh sobre a pressão intraocular em cirurgia não oftálmica

Resumo
Justificativa: Comparamos as alterações de pressão intraocular após laringoscopia e intubação com lâmina Macintosh convencional e laringoscópio óptico Airtraq.
Métodos: Noventa pacientes adultos foram randomicamente designados para os grupos estudo ou controle. No grupo estudo (n = 45), o laringoscópio Airtraq foi usado para laringoscopia e no grupo controle (n = 45), o laringoscópio Macintosh convencional foi usado para laringoscopia. A pressão intraocular foi mensurada no pré-operatório com tonômetro Schiotz. A laringoscopia foi realizada de acordo com o protocolo de cada grupo. Pressão intraocular e parâmetros hemodinâmicos foram registrados logo antes da inserção do dispositivo e três vezes após a inserção do dispositivo, com intervalo de um minuto.
Resultados: As características dos pacientes, os parâmetros hemodinâmicos basais e a PIO basal foram comparáveis nos dois grupos. Após a inserção do tubo endotraqueal com o laringoscópio Macintosh, houve um aumento estatisticamente significativo da frequência cardíaca e da pressão intraocular em comparação com o grupo Airtraq. Não houve alteração significativa da PAM. Oito pacientes do grupo Macintosh sofreram trauma de língua-lábio-dental durante a intubação, enquanto apenas dois pacientes sofreram trauma das vias aéreas superiores no grupo Airtraq.
Conclusão: Concluímos que o laringoscópio Airtraq, em comparação com o laringoscópio Macintosh, resultou em elevações significativamente menores da PIO e em aumentos clinicamente menos acentuados da resposta hemodinâmica à laringoscopia e intubação.

Introduction

Tracheal intubation with traditional Macintosh laryngoscope is associated with increase in intraocular pressure (IOP) along with tachycardia and hypertension. These effects are not desirable in patients with raised intra-ocular pressure. The Airtraq (Prodol Meditec S.A., Vizcaya, Spain) is a novel optical laryngoscope that has been developed to facilitate tracheal intubation.[1] As a result of the exaggerated curvature of the blade and an internal arrangement of optical components, a view of the glottis is provided without alignment of the oral, pharyngeal and laryngeal axes.[2] As a result, intubation is much less stimulating to the patient. Therefore, Airtraq optical laryngoscope assisted intubation could be a preferable technique which offers advantages in terms of intraocular pressure and cardiovascular stability.

In this study, we compared the effects of IOP to intubation with conventional Macintosh laryngoscope and Airtraq optical laryngoscope (Fig. 1). We also compared haemodynamic changes and post-operative airway trauma.

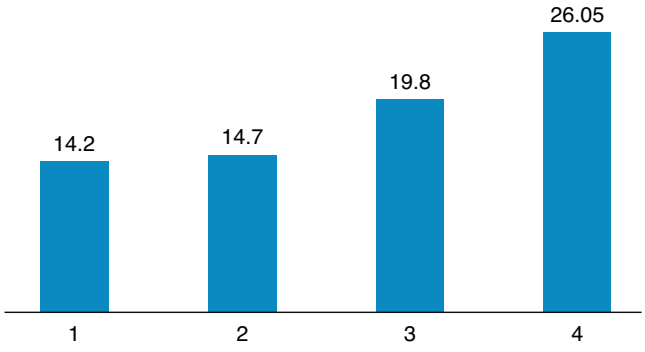

Figure 1 Comparison of IOP between Macintosh and Airtraq. (1) Airtraq pre-insertion; (2) Macintosh pre-insertion; (3) Airtraq immediate post-insertion; (4) Macintosh immediate post-insertion.

Materials and methods

Following approval by the Hospital Ethics Committee, and written informed patient consent to participate in the study, we studied 90 ASA physical status I–III patients, aged between 18 and 65 years, scheduled for surgical procedures requiring tracheal intubation, in a randomised, single blind, controlled clinical trial. Patients were not included if risk factors for gastric aspiration and/or risk factors for difficult intubation (Mallampatti class III or IV; thyromental distance less than 6 cm; interincisor distance less than 4.0 cm) were present, patients were with raised intra-ocular pressure or where there was a history of relevant drug allergy. All data were collected by an independent, unblended observer.

Ninety patients were equally randomised into one of the two groups (Macintosh and Airtraq) of 45 each for airway management using computer generated randomisation programme and the patient was blinded to their group assignment. All patients received a standardised general anaesthetic. Standard monitoring, including electrocardiography (ECG), non-invasive blood pressure

(NIBP), pulse oximetry, end tidal carbon dioxide ($EtCO_2$) and volatile anaesthetic levels, was continuously performed. Prior to induction of anaesthesia, all patients were given fentanyl (2 μg/kg) intravenously. A sleep dose of propofol (2–3 mg/kg) was titrated to induce anaesthesia. Following induction of anaesthesia, all patients' lungs were manually ventilated with sevoflurane (2.0%–2.5%) in oxygen, atracurium 0.50 mg/kg was administered, and the trachea was intubated 3 min later, by an anaesthetist, experienced in the use of both laryngoscopes. Thereafter, the lungs were mechanically ventilated for the duration of the procedure and anaesthesia was maintained using sevoflurane (1.25–1.75%) in a mixture of nitrous oxide and oxygen in a 2:1 ratio.

$EtCO_2$ was kept below 40 mmHg. No other medications were administered, or procedures performed, during the 5-min data collection period following tracheal intubation.

IOP was measured in both the eyes (previously prepared with lubricant eye drop) just before insertion of the device and subsequently three times at an interval of one minute after insertion of the device using Schiotz tonometer (The Diagnostic Company: Riester, Germany). Haemodynamic parameters which included heart rate, mean, systolic and diastolic blood pressure were recorded simultaneously at the time of measuring IOP. Blood staining of the device was noted after removal and tongue-lip-dental trauma were recorded in the post-anaesthesia care unit.

Sample size was selected to detect a projected difference of 25% between the groups with respect to IOP for a type I error of 0.05 and a power of 0.9 and the power of analysis was based on a previous study of IOP measurement with Macintosh laryngoscope.[3] Data are represented as mean ± SD. Between group comparisons were done using Student's *t* test and non-parametric Mann–Whitney test in case data did not follow normal distribution. Airway trauma was compared using Fisher's exact test. *p* value <0.05 was considered significant.

Result

A total of 90 patients were studied, 45 in each subgroup. No significant differences between the subgroups were seen with regard to age, sex, and weight (Table 1).

Table 1 Demographic parameters. Data are mean (SD).

	Macintosh ($n = 45$)	Airtraq ($n = 45$)
Age (years)	40.25 (9.44)	44.15 (11.22)
Weight (kg)	69.10 (5.22)	63.65 (10.78)
Male:female	29:16	32:13

There was no significant difference in heart rate ($p = 0.88$), mean blood pressure ($p = 0.51$) and IOP ($p = 0.57$) before insertion of the airway devices between the two groups (Table 2). Following insertion of the endotracheal tube with Macintosh laryngoscope, there was statistically significant rise in heart rate compared to Airtraq group. There was no significant change in MAP ($p = 0.997$). The IOP measured after intubation in Macintosh group was 26.05 ± 3.02 mmHg and 19.8 ± 3.12 mmHg in Airtraq group and this was statistically significant ($p = 0.023$) (Table 2).

Eight patients in Macintosh group had tongue-lip-dental trauma during intubation, while only 2 patients received upper airway trauma in Airtraq group. This was also statistically significant ($p = 0.0496$) (Table 3).

Discussion

Direct laryngoscopy and tracheal intubation have been constant concerns with regard to regular occurrence of the pressor responses associated with it. The haemodynamic responses, manifesting as increase in heart rate and blood pressure, are due to reflex sympatho-adrenal discharge provoked by epilaryngeal and laryngotracheal stimulation subsequent to laryngoscopy and tracheal intubation.[3–6] The stress response to tracheal intubation and extubation is also associated with increase in IOP.[7–11] The mechanism of IOP rise is secondary to increased sympathetic activity. Adrenergic stimulation causes vaso and venoconstriction, and an increase in central venous pressure, which has a close relationship with IOP.[12] In addition adrenergic stimulation can also produce an acute increase in IOP, by increasing the resistance to the outflow of aqueous humour in trabecular meshwork between anterior chamber and Schlemn's canal.[13] This explains the close relationship between haemodynamic and IOP response which was also seen in our study.

Table 2 Comparison of the measured parameters between the two groups. Data are mean (SD).

	Macintosh ($n = 45$)	Airtraq ($n = 45$)	*p*-Value
Heart rate (bpm)			
Pre-insertion	83 (10.12)	78.55 (8.53)	0.88
Immediate post-insertion	105.2 (4.66)	94.35 (4.95)	0.01[a]
MAP (mmHg)			
Pre-insertion	76.3 (7.73)	77.3 (6.40)	0.51
Immediate post-insertion	93.1 (5.42)	87.1 (6.59)	0.997
IOP (mmHg)			
Pre-insertion	14.7 (2.51)	14.2 (2.94)	0.57
Immediate post-insertion	26.05 (3.02)	19.8 (3.12)	0.023[a]

Bpm, beats per minute; MAP, mean arterial pressure; IOP, intra-ocular pressure.
[a] Statistically significant.

Table 3 Comparison of airway trauma.

	Macintosh ($n = 45$)	Airtraq ($n = 45$)	p-Value
Airway trauma			
Yes	8	2	
No	36	48	0.0496

The acute increase in IOP may be dangerous for patients with impending perforation of eye, perforating eye injuries, glaucoma, etc. This problem has drawn the attention of many workers to study the attenuation of these responses with some pre-treatment or by some alternative to laryngoscopy and tracheal intubation, viz. LMA. Lignocaine pre-treatment, either intravenous or nebulised has been used to attenuate ocular and systemic responses to laryngoscopy and tracheal intubation.[7,9,10] Intranasal nitroglycerine has also been evaluated to prevent increase in IOP associated with tracheal intubation.[11] LMA, as an alternative to endotracheal tube has attracted the attention of many workers with regards to IOP changes, as it obviates the need for laryngoscopy and tracheal intubation. Holden et al.[14] were the first to compare the IOP changes using LMA and endotracheal tube and their observations as well as those of Lamb et al.[15] revealed a significantly smaller increase in IOP using LMA both on placement and removal as compared to endotracheal intubation. Similar results were reported by Whitford et al.[16] and Duman et al.[17]

In our study we found that there was significant increase in heart rate and IOP after airway instrumentation in the Macintosh group compared to the Airtraq group. But the increase in MAP is not significant. These findings of our study are in accordance with the study of Casati et al.[18] The two main causes of haemodynamic responses to tracheal intubation are stimuli to oropharyngeal structures produced by laryngoscopy, and stimuli to the larynx and trachea secondary to tube insertion.[19] A possible explanation for why the Airtraq may better attenuate the haemodynamic stress response compared to Macintosh is that it minimally stimulates the airway stress receptors.

Arterial pressure plays a role in control of IOP but has a relatively minor role if the arterial pressure is in the physiological range.[20,21] In patients with an initial IOP > 11 mmHg, no correlation with arterial pressure was found but a good correlation existed between the IOP and central venous pressure (CVP).[22] In our study, the baseline IOP in both the groups was more than 11 mmHg and no significant correlation was found between MAP and IOP in Airtraq group. A significant rise in IOP was found in Macintosh group, which could be a consequence of greater pressor response to laryngoscope guided tracheal intubation. We did not study the correlation of IOP with CVP because CVP monitoring was not indicated in the allotted cases.

In our study MAP in the Macintosh group was not increased significantly compared to the Airtraq group. Greater sympathetic stimulation is required to increase arterial blood pressure than to increase heart rate and IOP.[23] As patients were premedicated with fentanyl and induced with propofol, that amount of sympathetic stimulation was not reached. So, heart rate and IOP were increased significantly in Macintosh group, but MAP was not increased significantly.

IOP is also known to increase after a rise in $PaCO_2$ as a result of choroidal vasodilatation or elevation of CVP or possibly a combination of both the mechanisms.[24] We ensured Normocapnia throughout the intra-operative period (end tidal CO_2 = 35–40 mmHg).

We found a significant rise in IOP post-Airtraq guided intubation from the pre-insertion values (mean IOP = 14.2 mmHg), with the rise being 19.8 mmHg. The mean rise in IOP was within the normal range of 10–20 mmHg, which should not be deleterious to a normal eye but can be harmful for a patient with glaucoma or hypertension.

Increased number of airway trauma in Macintosh group resulted from greater force required to visualise laryngeal opening.[25] This would have also probably resulted in increased IOP due to raised arterial pressure as well as raised CVP. But we did not measure any direct correlation between airway trauma and raised IOP in this study.

Conclusion

We conclude that Airtraq optical laryngoscope would be a better option of endotracheal intubation than the Macintosh laryngoscope in patients having raised intra ocular pressure. Haemodynamic pressor response and airway trauma are also less with Airtraq.

Conflicts of interest

The authors declare no conflicts of interest.

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